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Sustainable Corporate Models for Beef Cattle to Support the Acceleration of National Beef Self-Sufficiency

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The establishment of a beef cattle corporation represents a strategic move toward the industrialization of beef cattle using local resources. This initiative, involving breeder groups, traders, and small to medium-sized entrepreneurs, aims to stimulate strategic economic activities both on and off the farm within the beef cattle industry. The goal is to integrate these activities into a comprehensive agribusiness system that enhances national food security through sustainable beef cattle production, competitive practices, and equitable benefits for all stakeholders. The research focuses on evaluating the sustainability of the beef cattle corporation at the D'Reppa Cattle House in Gowa Regency. Using survey and interview methods, the study applied the Rap-Local Beef Cattle coordination technique with the Multi-Dimensional Scaling (MDS) approach for sustainability analysis. Findings indicate that the economic aspect of the D'Reppa Cattle House's sustainability is highly robust. However, the ecological, socio-cultural, technological, and institutional dimensions are only moderately sustainable. This suggests that while the corporation's attributes generally reflect favorable conditions across the five analyzed dimensions, particular attention is needed to improve the ecological dimension, especially regarding the distance between cattle pens and residential areas. By implementing these policies into practice, D'Reppa becomes a model for other cattle companies and solidifies its position in ecological sustainability. In addition to helping the business, the beneficial effects will support worldwide efforts to address climate change and environmental degradation and preserve ecological balance. All things considered, the D'Reppa beef cattle corporation's sustainability initiatives have the potential to significantly affect social, economic, and environmental factors as well as national policy. Adoption of technology, effective management, and cooperation with relevant parties to build a sustainable system are all necessary for this achievement.

Keywords: Livestock cooperatives, food supply, environmental sustainability , Triple Bottom Line, Social-Ecological Systems.

INTRODUCTION

The livestock sector in Indonesia plays a crucial role in the national economy and positively impacts society, with demand steadily rising each year. Beef cattle, a key commodity in this sector, are typically managed by small-scale farmer households, which usually own only 2-3 cattle on average. This small-scale ownership poses challenges in meeting beef demands and hinders the advancement of beef cattle farming towards industrialization, due to low efficiency and part-time operations. To enhance efficiency and enable the establishment of viable business units, it is essential to increase the economic scale of operations, adopt effective business management practices, and implement production technologies in a coordinated and simultaneous manner. Consequently, developing beef cattle corporations through

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the empowerment and corporatization of breeders—such as forming cooperatives or other legal entities—becomes necessary (Rusdiana and Soeharsono 2017; Siregar *et al.,* 2018).

Despite being essential to global food supply, the beef cattle industry faces a number of sustainability-related challenges, particularly in emerging countries like Indonesia. When it comes to achieving social, environmental, and financial sustainability, smallholder farmers who join corporate beef cattle enterprises have both benefits and drawbacks. Despite several initiatives, such as the "Cattle Breeding Village" program, little is known about the sustainability of beef cattle operations in Indonesia. This study addresses a gap in the literature by analyzing the sustainability performance of Indonesian beef cattle enterprises using the D'Reppa Cattle House as a case study. The study aims to assess the economic, environmental, and social impacts of corporate models in beef cattle production in order to give a comprehensive understanding of their viability and long-term sustainability. Given the growing demand for beef globally and the importance of sustainable farming practices, this study contributes to the broader discussion on the sustainability of agricultural companies in developing countries. It also provides industry stakeholders and policymakers with useful information to improve the sustainability of Indonesia's beef cattle sector.

In Indonesia, most beef livestock enterprises are smallholder operations that use traditional methods, often integrating livestock with crop farming. These traditional practices are characterized by small-scale operations, rudimentary technology, basic feeding, and part-time involvement, resulting in low productivity for beef cattle. Beef cattle maintenance can be categorized into two types: breeding stock and feeder cattle for fattening. Typically, cattle farming in Indonesia is conducted on a small scale by individual farmers. The challenge for these smallholder farms is that they struggle to become profitable due to their part-time nature. When farmers need cash, they often sell their cattle, which weakens their bargaining position and hampers the growth of their cattle businesses (Sirajuddin *et al.,* 2020).

In Indonesia, smallholder farmers, cooperatives, and commercial businesses typically form agreements to form beef cattle firms. In order to provide access to improved breeding stock, nutrition, and veterinary care, the initiative seeks to include regional farmers into structured supply networks. Notwithstanding these benefits, there are still issues, such as restricted financial options, poor infrastructure, and erratic government assistance. The integrated agricultural method, which blends crop production with livestock husbandry, is another illustration. The use of cattle dung as organic fertilizer is one example of how this strategy promotes resource efficiency. However, due to tiny landholdings and restricted market access, scaling is still a problem.

Livestock models in other countries, Large-scale, highly developed operations are a defining feature of beef cattle enterprises in Australia. Precision livestock farming (PLF) technology, such automated feeding systems and real-time health monitoring, are frequently used by these companies. Strong market focus, reliable logistics, and respect to animal welfare standards are the keys to these models' success. Climate unpredictability and the high costs of adopting new technologies are challenges. Large ranches that combine agricultural cultivation and grazing techniques dominate the beef cattle market in Brazil. Initiatives like the ABC Program's "Low Carbon Agriculture" promote sustainable methods like reforestation and rotational grazing. Concerns about deforestation and the necessity of striking a balance between environmental sustainability and productivity are the main obstacles. Across countries, successful beef cattle corporations share common best practices (Allan *et al.,* 2025): (1) Minimizing waste through integrated systems; (2) Leveraging PLF and data-driven decision-making; (3) Developing value chains that connect producers to consumers; and (4) Training programs to enhance farmer skills and knowledge. The beef cattle farming sector is currently facing a shortage of feeder cattle due to a mismatch between population growth and national demand, leading to imports of feeder cattle and beef. In Indonesia, the beef supply comes from three main sources: smallholder farms, cattle fattened from imports, and imported beef. Indonesia is still working to boost the number of cattle through a number of government initiatives (Astaman *et al.,* 2022). The annual increase in cattle population remains minimal, contributing to low productivity in both beef cattle and breeding stock (Hajirin *et al.,* 2020), to maintain a balance between the supply and demand for beef, it is essential to keep smallholder livestock businesses as a primary focus.

This study links its analysis to three prominent sustainability theories to comprehensively evaluate the performance of beef cattle corporations. The Triple Bottom Line (TBL) framework emphasizes the need to balance social, environmental, and economic dimensions of sustainability. It is applied here by assessing economic sustainability through cost-efficiency, revenue generation, and market stability; environmental sustainability through efforts to reduce greenhouse gas emissions, conserve water, and improve soil health; and social sustainability through contributions to job creation, equitable income distribution, and community empowerment (Boatright, 2017). The Natural Capital Theory underlines the importance of preserving natural resources as critical assets, which this study addresses by examining how beef cattle corporations manage grazing grounds, water resources, and biodiversity. Lastly, the Social-Ecological Systems (SES) Framework highlights the interdependence of human and ecological systems, which is used in this study to analyze the resilience of beef cattle corporations to external shocks such as climate change and market fluctuations

(Ostrom, 2009).

Other challenges in developing beef cattle farming include insufficient capital, a lack of efforts to expand the scale of operations, limited human resources, and basic knowledge among those involved. Additionally, there is minimal support and guidance from experts in the field (Wahyudi *et al.*, 2021). The growth of beef cattle farming is closely linked to the area's carrying capacity, which encompasses both the availability of space for livestock and the supply of feed necessary for their survival. Adequate forage is crucial for the success of beef cattle operations. Converting land for agricultural purposes can enhance the quality of forage available to livestock. Beef cattle remain a significant source of income with substantial economic value, playing a crucial role in people's lives. They not only meet various needs, particularly for food, but also provide additional income, making them a valuable investment for farmers. To boost domestic livestock production and improve the rural economy, many breeders aim to enhance community welfare, which is closely tied to farmers' income and overall well-being (Solikin *et al.*, 2018).

A beef cattle farming business can be considered successful if it generates income and meets the daily needs of farmers. This success is often reflected in the growth and development of rural areas, which are closely linked to advancements in agriculture. Farmers' income is influenced by the number of cattle they manage and the effectiveness of their management practices—more cattle typically lead to higher profits. However, challenges arise as agricultural land becomes increasingly limited due to growing production demands, leading to reduced income while needs continue to rise. Consequently, farmers may seek additional sources of income by engaging in multiple types of work to support their livelihoods (Rohani *et al.*, 2021).

The development of beef cattle corporations should be conducted in a comprehensive and sustainable manner within a livestock business framework, taking into account socio-cultural, technical, economic, and ecological factors. This approach not only enhances value but also boosts the competitiveness of beef cattle, fosters economic growth, stimulates investment, and creates business opportunities. Additionally, it supports job creation and improves the welfare of farmers. This study will provide new insights into how the D'Reppa beef cattle corporation can develop in a more holistic way and have a positive impact on the environment and society by integrating ecological and socio-cultural factors into a sustainability model. This will pave the way for more inclusive and integrated sustainability models, which can be adapted at both local and global levels.

A number of factors, particularly in developing countries like Indonesia, influence the performance of beef cattle operations, including access to government programs, infrastructure, and institutional support. Institutional assistance, such as initiatives like the "Cattle Breeding Village" program, is essential to enhancing the sustainability of smallholder farmers by integrating them into organized supply chains. These programs give farmers access to improved breeding stock, veterinary treatment, and management practices, all of which have the potential to significantly increase productivity and environmental sustainability.

Despite these advantages, there are also challenges. Lack of capital, inadequate infrastructure, and inconsistent government support continue to be obstacles to the growth and sustainability of beef cattle enterprises. These institutional challenges are made worse by elements such as small landholdings, limited market access, and a lack of programs aimed at enhancing the ability of regional farmers. Therefore, even though institutional support is necessary for sustainable beef cattle ranching, these structural limitations usually make it less effective. These gaps must be addressed if beef cattle businesses are to succeed and grow over time, particularly in terms of integrating smallholder farmers into the formal agricultural economy. Consequently, institutional entities are a complex and integral aspect of agricultural development (Arsyad *et al.*, 2021). Similarly, in Gowa Regency, government programs have been extensively implemented in the community. To meet their objectives, effective institutional oversight and strengthening are essential. One such program in Gowa Regency is the beef cattle livestock corporation. However, this initiative has not yet achieved its full potential, with services remaining limited and often inadequate. This is attributed to various obstacles and challenges encountered (Huruta *et al.*, 2017).

The Gowa Regency Regional Government has high expectations for its role as a key area for beef cattle development in South Sulawesi. To support this, it is crucial to gather data and information that highlight the role of beef cattle livestock corporations. This will help in mapping their roles, designing strategic plans, and strengthening these institutions as a foundation for developing programs aimed at improving beef cattle production and population in Gowa Regency. Consequently, research into sustainability models for beef cattle corporations is needed to aid in the acceleration of national beef self-sufficiency in Indonesia. Evaluating and creating a sustainability model that incorporates institutional, technical, sociocultural, ecological, and economic aspects of business operations is the goal of D'Reppa's research on corporate sustainability in beef cattle. This research aims to develop a sustainability plan that the beef cattle sector may use as a guide to balance financial interests with social and environmental obligations.

MATERIALS AND METHODS

***Research site*:** The Reppa Cow House in Gowa Regency, South Sulawesi, Indonesia, served as the study's location. Gowa Regency is one of five crucial provinces for the growth

of beef cattle that were chosen for the greatest national program of the Indonesian central government of agriculture. As a result, researchers were able to get precise information on the direction of beef cattle growth in relation to the livestock corporate system (via the Reppa Cow House). Because it is a successful example of beef cattle company sustainability in Indonesia, the D'Reppa Cattle House was chosen as the research location. This location was picked because it consistently applies best practices in animal husbandry, integrates smallholder farmers into a structured corporate framework, and pioneered ecologically friendly cow farming techniques. Furthermore, D'Reppa has received recognition for its contributions to community development and local economic empowerment, which fits in nicely with the sustainability research emphasis.

Sampling technique: The informants included: (1) the manager of D'Reppa Cattle House, (2) beef cattle breeders, and (3) selected university representatives. Data were gathered through focus group discussions and interviews. The analysis employed the Rap-Local Beef Cattle Breeding coordination technique and the Multi-Dimensional Scaling (MDS) method, evaluating five key dimensions: economic, ecological, socio-cultural, technological, and institutional (Prasodjo, 2015; Yusuf *et al.*, 2021).

The Rap-Local Beef Cattle coordination technique, which employs the MDS method, involves several steps: (1) Identifying 30 attributes across five sustainability dimensions for this study. Specifically, there are 6 attributes for the economic dimension, 6 for the ecological dimension, 6 for the socio-cultural dimension, 6 for the technological dimension, and 6 for the institutional dimension.

***Data collection tools*:** To collect qualitative data, the study used focus group discussions (FGDs) and semi-structured interviews. The interview questions centred on important facets of business operations, including as: Economic Performance (about profitability, cost management, and market access), Ecological Practices (about waste management, grazing practices, and use of renewable energy), Socio-cultural (Discussions on employment generation, income distribution, and community partnerships), Technology (about feed technology, recording, reproduction, health and disease technology), and Institutional aspect (role and function of stakeholders). Through stakeholder perspectives of sustainability, the FGDs identified possibilities and difficulties in the production of beef cattle. Farmers, business executives, public servants, and members of the local community were among the participants.

***Data triangulation*:** To enhance data reliability and validity, multiple data collection methods were employed:

1. ***Surveys*:** A structured questionnaire was distributed to 150 stakeholders to quantify perceptions of sustainability.
2. ***Document analysis*:** Corporate reports, government policies, and prior research studies were reviewed to contextualize findings.
3. ***Field observations*:** Site visits were conducted to observe operational practices and environmental conditions directly.

The selection of these attributes is informed by earlier research (Ramadhan *et al.*, 2014; Sriroso *et al.*, 2013; Sutanto and Hendraningsih 2011; Astutik *et al.*, 2019; Maryono 2018), and adjusted based on commodities and conditions of the research location; (2) Coordination analysis with MDS is used to determine the position of sustainability status in each dimension on the sustainability index scale; (3) Assessing the sustainability index and status in each dimension, the sustainability index scale has a value of 0-100 percent: (a) $00.00 < x \leq 25.00$ is not sustainable; (b) $25.01 < x \leq 50.00$ less sustainable; (c) $50.01 < x \leq 75.00$ is quite sustainable; and (d) $75.01 < x \leq 100.00$ is very sustainable. (4) Next, the corporate sustainability index values for beef cattle in each dimension (economic, ecological, socio-cultural, technological and institutional) are visualized on a flyover diagram.

Table 1. Dimensions and attributes of research variables.

Dimensions	Attribute
Economic dimensions	1. Price of beef cattle 2. Level of beef cattle sales 3. Beef cattle productivity 4. Profit level per head of beef cattle 5. Competitiveness of beef cattle 6. Feasibility of beef cattle farming
Ecological dimensions	1. Utilization of beef cattle waste as organic fertilizer 2. Utilization of agricultural waste as feed for beef cattle 3. Distance from the location of the beef cattle pen to residential areas 4. Availability of land for beef cattle food crops 5. Availability of beef cattle breeds 6. Agro-climatic conditions
Socio-Cultural dimensions	1. Education level of livestock corporation members 2. Family participation in the beef cattle farming business 3. Allocation of time used for beef cattle farming 4. Level of acceptance of corporate members in the beef cattle farming business 5. Frequency of counseling and training attended by livestock corporation members 6. Labor absorption rate
Technological dimensions	1. Technology for making beef cattle feed 2. Level of mastery of beef cattle farming technology 3. Facilities and infrastructure for beef cattle farming 4. Management of beef cattle records 5. Beef cattle breeding and reproduction system 6. Health and disease prevention of beef cattle

Institutional dimensions	1. Availability of artificial insemination staff 2. The role of the livestock and plantation service 3. The role of beef cattle corporations 4. The role of livestock instructors 5. The role of marketing institutions 6. The role of universities

Source: Primary data, 2024.

Distance determination or ordination techniques in MDS are based on Euclidian Distances in n-dimensional space; and (5) Assessment of good model accuracy (goodness of fit) in MDS can be seen from the magnitude of the S-Stress and R2 values. In Rapfish, a good model can be seen at an S-stress value that is smaller than 0.25 (S<0.25), while the R2 value is close to 1. The dimensions and attributes of each dimension can be seen in Table 1.

The TBL and SES frameworks, two theoretical frameworks of sustainability, served as the foundation for the qualities chosen for MDS analysis. Attributes were selected for each sustainability component according to their measurability and applicability to the beef cattle industry. These attributes were finalized after consulting stakeholders and reviewing relevant literature to ensure their alignment with broader sustainability objectives.

***Data interpretation*:** Spatial mapping will be used to analyze the MDS results, revealing parallels or differences in sustainability performance based on the relative distances between data points. Important actions consist of:

1. Dimension Reduction, visualizing multi-dimensional data in a two-dimensional space to identify patterns and clusters.
2. Performance Assessment, Comparing the sustainability profiles of different operational units or time periods to evaluate strengths and weaknesses.
3. Actionable Insights, Using the identified clusters and outliers to recommend specific improvements, such as enhancing resource efficiency or addressing social inequities.

The findings will be used as a diagnostic tool to evaluate beef cattle companies' sustainability performance, allowing for focused interventions to enhance results in the areas of economics, the environment, and society.

***Ethical considerations*:** Throughout the research procedure, ethical issues were closely monitored to guarantee the safety and welfare of every participant. Important actions included:

1. Before beginning the research, each participant received comprehensive information regarding its goals, methods, and possible effects. Their free decision to participate was confirmed by written consent.
2. Second, Participants' identities and responses were kept confidential. Data were anonymized during analysis and stored securely to prevent unauthorized access.
3. Next step, potential effects on the study location were taken into consideration in the research design. The D'Reppa Cattle House's operational activities were carefully disrupted as little as possible. To ensure openness and reciprocity, feedback sessions were held to communicate findings with stakeholders.
4. Last important step**,** the work complied with accepted standards for research involving human participants after being examined and authorized by the institutional ethics committee.

Operational definitions

1. ***Economic sustainability*:** Economic sustainability refers to the ability of a system or organization to maintain long-term financial viability while supporting equitable economic growth. In the context of beef cattle corporations, it emphasizes optimizing resource use, ensuring profitability, enhancing cost-efficiency, and fostering stable market integration. Key indicators include return on investment (ROI), revenue generation, and the financial resilience to withstand market fluctuations.
2. ***Ecological sustainability*:** Ecological sustainability involves the responsible management of natural resources to minimize environmental degradation and ensure the health of ecosystems for future generations. For beef cattle corporations, this includes reducing greenhouse gas emissions, conserving water, improving soil health, and adopting sustainable grazing and waste management practices. It seeks to balance productivity with environmental stewardship, as measured by metrics like carbon footprint, water usage efficiency, and biodiversity preservation.
3. ***Socio-cultural sustainability*:** Socio-cultural sustainability encompasses the capacity of a system to respect and integrate social values, cultural practices, and community well-being into its operations. In the beef cattle sector, it emphasizes job creation, equitable income distribution, cultural inclusivity, and community empowerment. It also includes maintaining traditions related to livestock farming while fostering inclusive decision-making and social cohesion among stakeholders. Level of local participation in decision-making processes (Nye, 2021). Number of jobs created within the local community (Tavenner *et al.*, 2021).
4. ***Technological sustainability*:** Technological sustainability focuses on the adoption and application of technologies that enhance productivity, efficiency, and resilience without compromising environmental or social goals. In beef cattle corporations, it includes the use of precision livestock farming (PLF), automated feeding systems, and renewable energy technologies. This dimension ensures that technological advancements contribute to sustainability by reducing resource waste, improving animal welfare, and enabling data-driven decision-making.
5. ***Institutional sustainability*:** Institutional sustainability refers to the establishment of robust governance frameworks, policies, and organizational structures that support long-term sustainability goals. For beef cattle

corporations, this includes effective leadership, consistent policy implementation, access to institutional support (e.g. government programs and financial incentives), and collaboration among stakeholders. Institutional sustainability ensures continuity, transparency, and adaptability in responding to socio-economic and environmental challenges.

RESULTS

***Corporate sustainability of beef cattle based on economic dimensions at the D'Reppa cattle house, Gowa Regency*:** The analysis using the Rap-Local Beef Cattle method reveals that the sustainability index for the economic dimension of the beef cattle corporation at the D'Reppa Cattle House in Gowa Regency is 77.10% (falling within the range of $75.01 < x \leq 100.00$), which signifies a very sustainable level. The stress value is 0.14, which is below the acceptable threshold of 0.25. According to Yusuf *et al.* (2021) the model is relatively effective, with minimal stress, and is classified as very good due to the low stress value. Stress measures the discrepancy between the data and the model results; a lower stress value implies a better alignment between inequality and disparity, leading to a more accurate configuration map. Conversely, a higher stress value suggests a greater discrepancy between the data and the model, indicating larger errors. The R-Square (R^2) value of 0.94 indicates that the model accounts for 94% of the variation explained by these variables, demonstrating a high level of explanatory power. This means that the model is well-explained, with only 6% of the variation attributed to factors not included in the model. R-Square, which is the square of the correlation coefficient, measures the proportion of data variation that has been captured by the model through multidimensional scaling. It serves as an indicator of the model's accuracy and suitability. A higher R^2 value, closer to 1, signifies a better fit of the model to the data, whereas a value closer to 0 suggests a less suitable model. Figure 1 displays the sustainability index value of beef cattle corporations based on economic dimensions at the D'Reppa Cattle House, Gowa Regency.

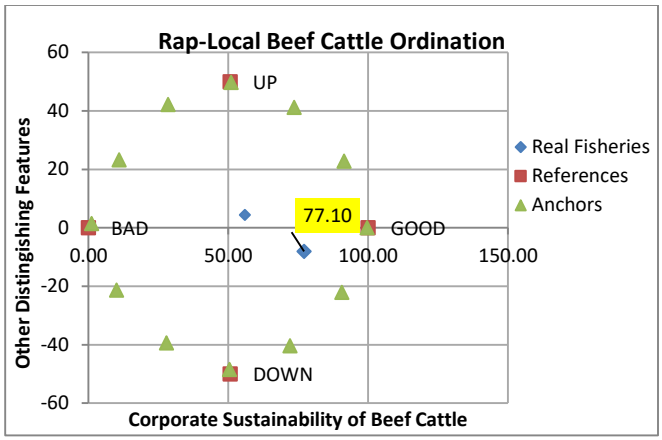

Figure 1. Beef cattle corporate sustainability index based on economic dimensions in the D'Reppa cattle house, Gowa Regency.

The leverage analysis of the six attributes within the economic dimension reveals that one particular attribute, the level of beef cattle sales (with a value of 11.00) (see Figure 2), is the most sensitive and influential in determining the sustainability of beef cattle corporations from an economic perspective

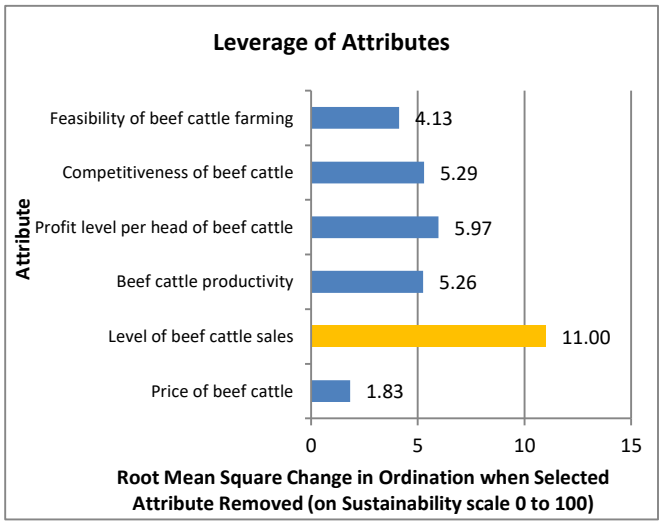

Figure 2. Analysis of leverage of attributes in the economic dimension.

***Corporate sustainability of beef cattle based on ecological dimensions at the D'Reppa cattle house, Gowa Regency*:** The analysis using the Rap-Local Beef Cattle method reveals that the corporate sustainability index for the ecological dimension at the D'Reppa Cattle House in Gowa Regency is 65.32% (within the range of $50.01 < x \leq 75.00$), indicating a moderate level of sustainability. The stress value is 0.15, which is below the acceptable threshold of 0.25. According to Yusuf *et al.* (2021) the model is relatively effective, with minimal stress, and is classified as very good due to the low

stress value. Stress measures the degree of discrepancy between the data and the model results; a lower stress value indicates a better alignment between data and the model, leading to a more accurate configuration map, whereas a higher stress value signifies greater discrepancies and larger errors.

The R-Square (R^2) value of 0.93 indicates that the model accounts for 93% of the variation explained by these variables, demonstrating a high level of explanatory power. This means the model is well-explained, with the remaining 7% of the variation attributed to factors not included in the model. R-Square, which is the square of the correlation coefficient, measures the proportion of the data's variation captured by the model through multidimensional scaling, serving as an indicator of the model's accuracy. It shows how well the data explains the model, or how effectively the independent variables account for the variation in the dependent variable. An R^2 value closer to 1 signifies a better fit of the model, while a value nearer to 0 indicates a less effective model. Figure 3 displays the sustainability index value of beef cattle corporations based on ecological dimensions at the D'Reppa Cattle House, Gowa Regency.

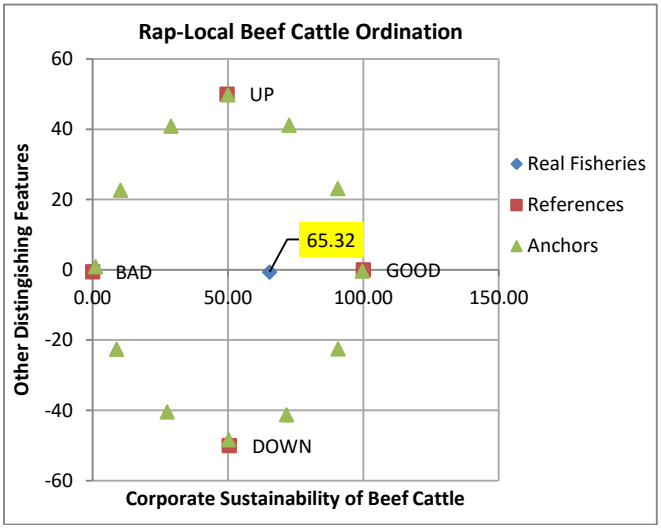

Figure 3. Beef cattle corporate sustainability index based on ecological dimensions in the D'Reppa cattle house, Gowa Regency.

The leverage analysis of the six attributes within the ecological dimension reveals that one particular attribute, the distance of the beef cattle pen from residential areas (with a value of 12.41) (see Figure 4), is highly influential and the most sensitive in determining the sustainability of beef cattle livestock corporations at the D'Reppa Cattle House in Gowa Regency.

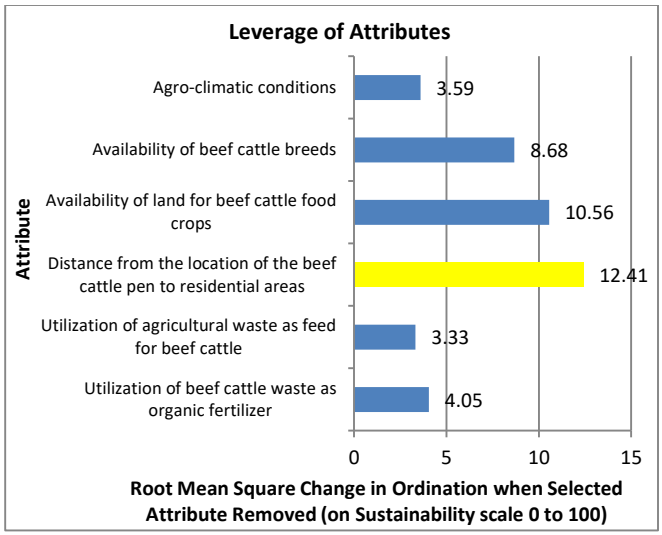

Figure 4. Analysis of leverage of attributes in the ecological dimension.

Figure 4 illustrates that the distance between the beef cattle pen and residential areas is a crucial ecological attribute with a significant effect on the sustainability index for beef cattle at the D'Reppa Cattle House in Gowa Regency.

***Corporate sustainability of beef cattle based on socio-cultural dimensions at the D'Reppa cattle house, Gowa Regency*:** The analysis using the Rap-Local Beef Cattle method indicates that the corporate sustainability index for the socio-cultural dimension at the D'Reppa Cattle House in Gowa Regency is 71.58% (falling within the range of $50.01 < x \leq 75.00$), reflecting a moderate level of sustainability. The stress value is 0.15, which is below the acceptable threshold of 0.25. According to Yusuf *et al.* (2021) the model is relatively effective, with minimal stress, and can be considered very good due to the low stress value. Stress measures the degree of discrepancy between the data and the model results; a lower stress value signifies a better alignment between the data and the model, resulting in a more accurate configuration map. Conversely, a higher stress value indicates greater discrepancies and larger errors.

The R-Square (R^2) value of 0.94 shows that the model accounts for 94% of the variation explained by these variables, demonstrating that the model is well-explained. The remaining 6% of the variation is either unexplained by the model or due to other factors not included. R-Square, which is the square of the correlation coefficient, represents the proportion of data variation captured by the model through multidimensional scaling, serving as an indicator of the model's fit and accuracy. A higher R^2 value, approaching 1, signifies a better model fit, whereas a value closer to 0 indicates a less effective model. Figure 5 displays the sustainability index value of beef cattle corporations based on socio-cultural dimensions at the D'Reppa Cattle House, Gowa Regency.

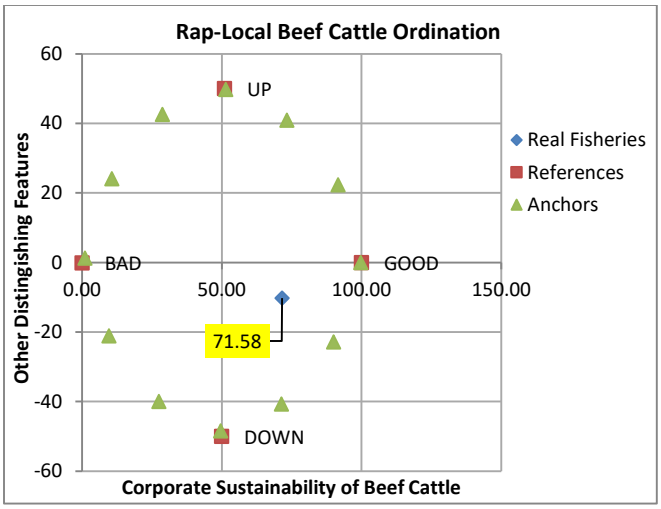

Figure 5. Beef cattle corporate sustainability index based on socio-cultural dimensions in the D'Reppa cattle house, Gowa Regency.

The leverage analysis of six attributes within the socio-cultural dimension reveals that one attribute, family participation in the beef cattle farming business (with a value of 9.87) (see Figure 6), is particularly influential and the most sensitive factor affecting the sustainability of beef cattle livestock corporations at the D'Reppa Cattle House in Gowa Regency.

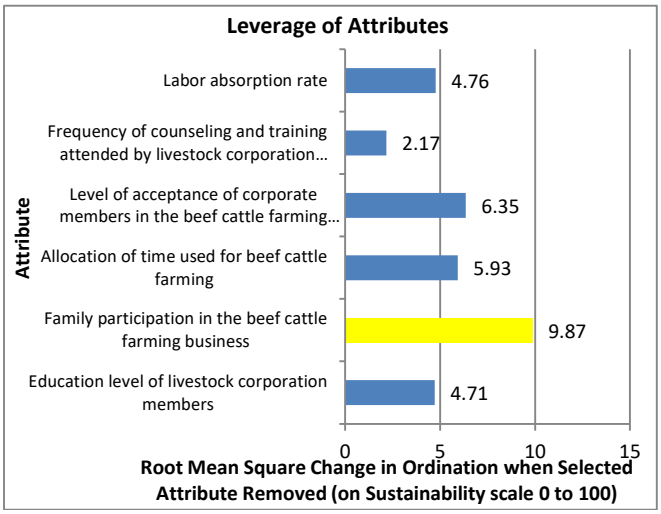

Figure 6. Leverage of attributes analysis on socio-cultural dimensions.

Figure 6 illustrates that family participation in the beef cattle farming business is a crucial socio-cultural attribute significantly influencing the sustainability index of the beef cattle corporation at the D'Reppa Cattle House in Gowa Regency.

***Corporate sustainability of beef cattle based on technological dimensions at the D'Reppa cattle house, Gowa Regency*:** The analysis using the Rap-Local Beef Cattle method reveals that the corporate sustainability index for the technological dimension at the D'Reppa Cattle House in Gowa Regency is 74.11% (within the range of $50.01 < x \leq 75.00$), reflecting a satisfactory level of sustainability. The stress value is 0.15, which is below the acceptable threshold of 0.25. This indicates that the model is relatively effective, experiencing minimal stress, and can be classified as very good due to the low stress value (Yusuf *et al.*, 2021). Stress measures the degree of discrepancy between the data and the model results; a lower stress value signifies a better alignment between the data and the model, leading to a more accurate configuration map, while a higher stress value indicates greater discrepancies and larger errors.

The R-Square (R^2) value of 0.94 indicates that the model accounts for 94% of the variation explained by these variables, demonstrating a high level of explanatory power. This means the model is well-explained, with the remaining 6% of the variation attributed to factors not included in the model. R-Square, which is derived from the square of the correlation coefficient, measures how well the data's variation is captured by the model through multidimensional scaling, serving as an indicator of the model's accuracy and fit. An R^2 value close to 1 suggests a better model fit, while a value closer to 0 indicates a less effective model. Figure 7 displays the sustainability index value of beef cattle corporations based on technological dimensions at the D'Reppa Cattle House, Gowa Regency.

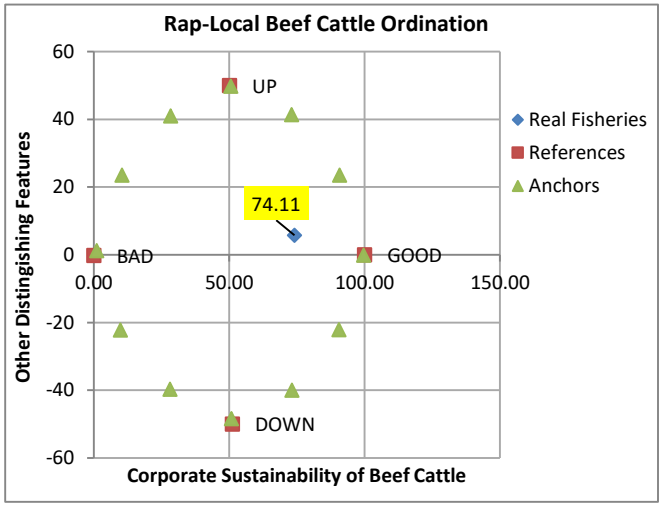

Figure 7. Beef cattle corporate sustainability index based on technological dimensions in the D'Reppa cattle house, Gowa Regency.

The leverage analysis of six attributes within the technological dimension reveals that one attribute, the management of beef cattle records (with a value of 5.49) (see Figure 8), is particularly influential and the most sensitive

factor affecting the sustainability of beef cattle corporations at the D'Reppa Cattle House in Gowa Regency.

Figure 8 illustrates that the management of beef cattle records significantly influences the corporate sustainability index for the technological dimension at the D'Reppa Cattle House in Gowa Regency.

***Corporate sustainability of beef cattle based on institutional dimensions at the D'Reppa cattle house, Gowa Regency*:** The analysis using the Rap-Local Beef Cattle method reveals that the corporate sustainability index for the institutional dimension at the D'Reppa Cattle House in Gowa Regency is 65.71% (within the range of $50.01 < x \leq 75.00$), indicating a moderate level of sustainability. The stress value is 0.14, which is below the acceptable threshold of 0.25. This suggests that the model is relatively effective, with minimal stress, and can be considered very good due to the low stress value (Yusuf *et al.*, 2021). Stress measures how well the data aligns with the model; a lower stress value indicates a better fit between the data and the model, resulting in a more accurate configuration, whereas a higher stress value signifies greater discrepancies and errors.

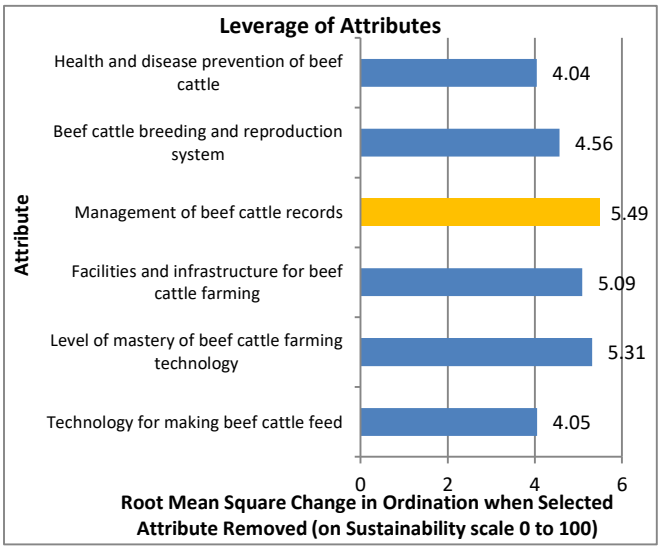

Figure 8. Analysis of leverage of attributes in the technology dimension.

The R-Square (R^2) value of 0.94 signifies that the model accounts for 94% of the variation in the data, demonstrating that it explains the data effectively. The remaining 6% of the variation is either unexplained by the model or due to factors not included within it. R-Square, which is derived from the square of the correlation coefficient, represents the proportion of variation captured by the model through multidimensional scaling, serving as a measure of accuracy and fit. A higher R^2 value, closer to 1, indicates a better fit of the model to the data, while a lower value, closer to 0, suggests that the model is less effective or suitable. Figure 9 displays the sustainability index value of beef cattle corporations based on institutional dimensions at the D'Reppa Cattle House, Gowa Regency.

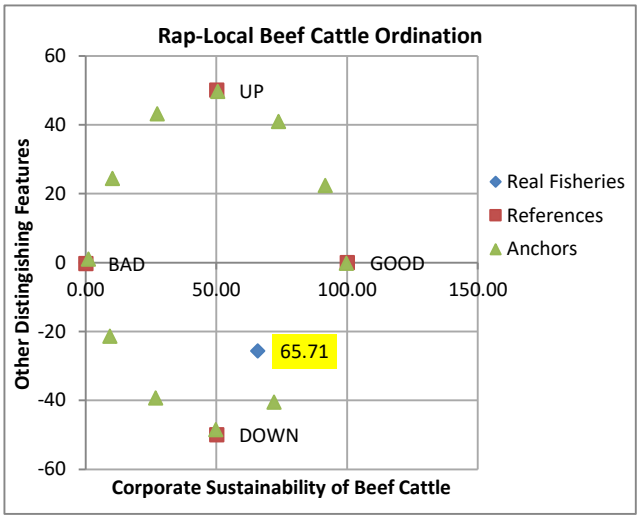

Figure 9. Beef cattle corporate sustainability index based on institutional dimensions in the D'Reppa cattle house, Gowa Regency.

The leverage analysis of six attributes within the institutional dimension reveals that one attribute, the role of the livestock and plantation department (with a value of 11.52) (see Figure 10), is particularly influential and the most sensitive factor affecting the sustainability of beef cattle corporations at the D'Reppa Cattle House in Gowa Regency.

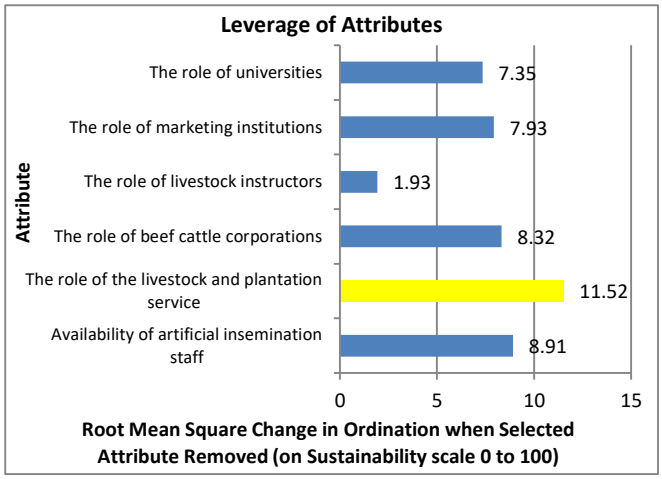

Figure 10. Analysis of leverage of attributes on the institutional dimension.

Figure 10 demonstrates that the role of the livestock and plantation service is a crucial attribute within the institutional dimension, significantly influencing the corporate sustainability index for beef cattle at the D'Reppa Cattle House in Gowa Regency.

***Corporate sustainability model for beef cattle at the D'Reppa cattle house, Gowa Regency*:** The analysis using the

Rap-Local Beef Cattle method indicates that the multidimensional corporate sustainability index for beef cattle at the D'Reppa Cattle House in Gowa Regency is 70.76% (within the range of $50.01 < x \leq 75.00$), reflecting a high level of sustainability. The stress value is 0.14, which is below the acceptable threshold of 0.25. According to Yusuf *et al.* (2021) the model is effective, with minimal stress, and can be classified as very good due to the low stress value. Stress measures the discrepancy between the data and the model's results; a lower stress value signifies a better fit between the data and the model, resulting in a more accurate configuration, whereas a higher stress value indicates greater discrepancies and larger errors.

The R-Square (R^2) value of 0.94 indicates that the model accounts for 94% of the variation in the data. This demonstrates that the model explains the data effectively, with the remaining 6% of the variation attributed to factors not included in the model. R-Square, derived from the square of the correlation coefficient, measures how well the data has been adjusted to the optimal scale through multidimensional scaling, which assesses the model's fit and accuracy. A higher R^2 value, closer to 1, signifies a better fit of the model to the data, whereas a value closer to 0 indicates a poorer fit and less effectiveness of the model. Figure 11 displays the corporate sustainability index value of beef cattle at the D'Reppa Cattle House, Gowa Regency in a multidimensional manner.

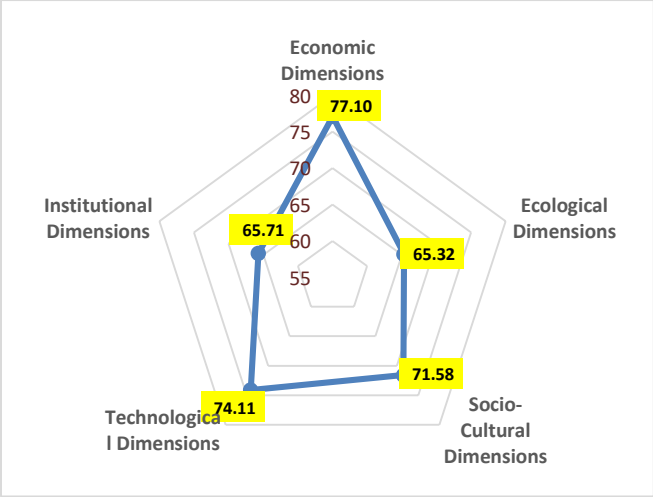

Figure 11. Corporate sustainability model for beef cattle at the D'Reppa cattle house, Gowa Regency.

Figure 11 illustrates that the MDS analysis revealed the economic dimension as having the highest score of 77.10%, followed by the technological dimension at 74.11%, the socio-cultural dimension at 71.58%, the institutional dimension at 65.71%, and the ecological dimension at 65.32%. These results indicate that the attributes used to assess the corporate sustainability index for beef cattle at the D'Reppa Cattle House in Gowa Regency generally perform well across the five dimensions analyzed. However, there is a need for focused attention and enhancement of the ecological dimension to improve the overall sustainability status of the beef cattle operations at the D'Reppa Cattle House.

DISCUSSION

1. Corporate Sustainability of Beef Cattle Based on Economic Dimensions at the D'Reppa Cattle House, Gowa Regency.

Figure 2 shows that the level of beef cattle sales does have a significant impact on livestock corporations, especially in the economic dimension. Here are some ways in which sales levels can affect the economic performance of the D'Reppa beef cattle corporation: (a) Corporate revenue and profit, (b) Economies of scale, (c) Investment in sustainable development, (d) Impact on financial stability, (e) Impact on price and market demand, (f) Impact on jobs and productivity, and (g) Impact on market diversification and product diversity.

The level of beef cattle sales has a very significant impact on the D'Reppa beef cattle corporation in the economic dimension. High sales support greater revenues, improve operational efficiency, provide flexibility in pricing strategies, and open up opportunities for business expansion. Overall, increasing sales not only has a direct effect on profits and growth, but also allows companies to invest in greater sustainability and diversification programs, supports financial stability, and strengthens competitiveness in the market.

As noted by (Andri, 2018), the revenue from livestock operations is directly related to the number of cows sold; thus, higher sales of cattle result in increased income for the farmer. Beef cattle farming has traditionally been conducted on an extensive basis, often without taking into account operational costs and the resulting profits. Consequently, it is essential to analyze income and assess the feasibility of the business. Such analysis is crucial as it helps farmers evaluate their business's sustainability and make informed decisions (Taek *et al.*, 2021).

The greater the number of beef cattle farmers own, the more they are motivated to swiftly adopt management technologies, with the goal of boosting their beef cattle production (Makatita, 2021). Typically, the success of a beef cattle farming operation is assessed based on the profit or loss it generates. To ensure the business remains viable, beef cattle farms need to maintain a strong financial position; specifically, the business must have revenues that surpass its costs. This is a crucial factor in evaluating the financial sustainability of the livestock operation (Hendayanta *et al.*, 2016).

From a development perspective, economic sustainability involves two key elements that are closely linked to the goals of other sustainability aspects. Macroeconomic sustainability focuses on achieving ongoing economic growth and

promoting economic efficiency through structural and national reforms (Sutawidjaya *et al.*, 2024; Scoones 2022).

2. Corporate Sustainability of Beef Cattle Based on Ecological Dimensions at the D'Reppa Cattle House, Gowa Regency.

Figure 4 shows that the distance from the location of the beef cattle pen to residential areas is an important attribute in the ecological dimension that can influence the sustainability index value of a D'Reppa beef cattle livestock corporation. The following are several ways in which this distance has a significant impact on the sustainability of beef cattle corporations based on ecological dimensions: (a) Impact on air quality and environmental pollution, (b) Management of animal waste and its impact on the environment, (c) Biodiversity and natural habitats, (d) Energy and resource management efficiency, (e) Impact on public health and social welfare, and (f) Implementation of sustainability policy.

The distance of the beef cattle pen to residential areas has a very significant impact on the value of the sustainability index in the ecological dimension. Choosing the right location helps reduce negative impacts on air, water and land quality, and minimizes disruption to local communities. In addition, longer distances provide space for implementing more efficient and environmentally friendly sustainability practices, as well as strengthening the reputation of livestock corporations in supporting social and environmental welfare. Ideally, a good distance for a beef cattle pen is around 250 meters from residential areas so as not to disturb the people who live around the farm. A good cage means it is far from residential areas, has good ventilation and air temperature, is efficient in management, strong and durable, has no impact on the surrounding environment and makes it easier for staff in production processes such as feeding, cleaning cages and health care.

Research (Ramadhan *et al.*, 2014) on the sustainability of beef cattle farming in Bondowoso Regency also identifies this distance as a key factor influencing the ecological dimension of the sustainability index.

Ecological sustainability refers to a biological system's ability to continually support biodiversity and productivity without constraints. It is essential for development and the ongoing viability of life. Ensuring ecological sustainability is crucial for the preservation of the Earth's ecosystems, which are intricate, dynamic, and continuously evolving (Sutawidjaya *et al.*, 2024; Scoones 2022).

3. Corporate Sustainability of Beef Cattle Based on Socio-Cultural Dimensions at the D'Reppa Cattle House, Gowa Regency.

Figure 6 shows that the attribute of family participation in the beef cattle farming business is one of the important attributes in the socio-cultural dimension which has a significant influence on the sustainability index value of the D'Reppa beef cattle livestock corporation in Gowa Regency. Family participation in animal husbandry not only contributes to economic success, but can also strengthen social and cultural relationships within the surrounding community. The following are some of the impacts of family participation on the sustainability index value of the socio-cultural dimension at the D'Reppa Cow House: (a) Strengthening local social and cultural values, (b) Increasing family economic welfare, (c) Increasing social resilience in communities, (d) The role of the family in implementing sustainability practices, (e) Increased involvement in decision making, and (f) Impact on social welfare and quality of life.

Family participation in the beef cattle farming business has a very significant impact on the sustainability index value of the socio-cultural dimension at D'Reppa Cow House, Gowa Regency. Family involvement in livestock operations contributes to the preservation of local traditions and wisdom, increasing economic prosperity, strengthening social resilience, and implementing more effective sustainability practices. Furthermore, this participation strengthens social relations at the local level and improves people's quality of life, leading to better social and cultural sustainability in the long term.

The farmer's involvement in managing the cattle reflects the time dedicated to the livestock rearing process, which is closely tied to the family's role in the business. The participation of family members in cattle rearing demands careful consideration of the time invested and the economic value of the labor provided. Although this labor's economic value may not always be directly compensated, it represents a significant contribution to the overall non-monetary income of the livestock business (Darmawi, 2012).

In farming households engaged in livestock businesses, work time is predominantly allocated to livestock activities (42.63%), with agricultural activities receiving the next highest share (40.67%), and non-agricultural activities the least (16.70%). The major source of household income for farmers raising livestock comes from agricultural activities (69.09%), followed by livestock businesses (21.54%), and non-agricultural activities (9.37%) ((Wahyuni 2014).

Livestock farming is a key source of income for farming households in rural areas. The role of men as family heads is crucial in generating family income. To balance their responsibilities, the family head must effectively manage their time between earning a livelihood, caring for the family, and seeking additional work to fulfill the needs of all family members (Afziani, 2014).

4. Corporate Sustainability of Beef Cattle Based on Technological Dimensions at the D'Reppa Cattle House, Gowa Regency.

Figure 8 shows that the recording management attributes of beef cattle play a very important role in improving the operational sustainability and results of beef cattle farming businesses, especially in the technological dimension. At D'Reppa Cow House, Gowa Regency, the implementation of good record management has a greater impact on the

company's sustainability index value based on the technological dimension. The following are several reasons why beef cattle record management can have a significant impact on sustainability in a technological dimension: (a) Utilization of technology in data recording, (b) Increased operational efficiency, (c) Improved livestock health, (d) Improved management of natural resources and the environment, (e) Increased transparency and accountability, and (f) Innovation and business development.

The management of beef cattle records at the D'Reppa Cow House, Gowa Regency, has a major impact on the sustainability index value in the technological dimension. The application of technology in recording allows for more efficient, accurate and data-based livestock management, which increases productivity, livestock health and environmental sustainability. A good recording system also supports transparency, accountability, and allows for better analysis and planning for future livestock business development. Therefore, technology-based record management is the key to ensuring the long-term sustainability of the beef cattle farming business at D'Reppa Cow House.

The adoption of technology in beef cattle farming can enhance productivity, increase the cattle population, and improve the quality of the beef. Therefore, to sustain and further improve the technological sustainability of the beef cattle corporation at the D'Reppa Cow House, it is crucial to continuously advance the use of reproductive technologies, feed production technologies, and record-keeping technologies across various locations (Adinata *et al.*, 2016).

5. Corporate Sustainability of Beef Cattle Based on Institutional Dimensions at the D'Reppa Cattle House, Gowa Regency.

Figure 10 shows that the role attribute of the Livestock and Plantation Service in the context of beef cattle farming at D'Reppa Cow House, Gowa Regency, is a very important attribute in the institutional dimension which has a significant impact on the value of the sustainability index. This service functions as an institution that has the authority and responsibility to regulate, develop and supervise livestock activities in the region. The following are some of the roles and impacts on the sustainability of the beef cattle farming business, especially at the D'Reppa Cow House: (a) Technical guidance and coaching, (b) Sustainability regulations and standards, (c) Funding policy and support, (d) Network and partnership facilitation, (e) Increasing public awareness and education, and (f) Increasing human resources capacity.

The role of the Livestock and Plantation Service as a government institution in Gowa Regency has a significant impact on the sustainability index value of the D'Reppa Cow House in the institutional dimension. Through technical guidance, implementing appropriate regulations, providing supportive policies, and facilitating access to funding and partnerships, this agency helps increase the efficiency and sustainability of beef cattle farming businesses. With the agency's active role in developing human resource capacity, strengthening networks, and providing education to the community, D'Reppa Cow House is able to survive and develop in facing challenges in the livestock sector.

The role of the livestock and plantation service in advancing beef cattle farming is well-recognized, with numerous programs and activities implemented to support and favor breeders. Livestock corporations highly anticipate further government support, including capital assistance, provision of high-quality cattle breeds, and credit facilities. The government has established various policy programs to enhance beef cattle farming, such as initiatives for beef self-sufficiency, superior cattle breeding, artificial insemination technology, and requirements for breeding pregnant cows. These programs are designed to benefit farmers and encourage the continued operation of their beef cattle businesses (Rusdiana and Talib, 2019).

6. Corporate Sustainability Model for Beef Cattle at the D'Reppa Cattle House, Gowa Regency.

Figure 11 shows that the results of the Multidimensional Scaling (MDS) analysis which shows the comparison of values for each sustainability dimension in the beef cattle livestock corporation at D'Reppa Cow House, Gowa Regency provide important insights into the factors that influence the sustainability of livestock businesses. Here is an in-depth analysis based on the findings: (a) Economic Dimension (Score 77.10%): Advantages of the Economic Dimension: The economic dimension has the highest value, which shows that the financial sustainability and profitability of the beef cattle farming business at D'Reppa Cow House is quite good. Success in the economic aspect can be influenced by aspects such as management of beef cattle sales, efficient use of resources, and the ability to generate sufficient profits in the long term, (b) Technology Dimension (Score 74.11%): The Role of Technology in Sustainability: The technology dimension with a value of 74.11% shows that the application of technology in livestock businesses has made a significant contribution to efficiency and productivity. The technology implemented at D'Reppa Cattle House, such as digital recording, technology-based livestock health monitoring, or feed management, helps speed up managerial processes and minimize errors, (c) Socio-Cultural Dimensions (Score 71.58%): The Role of Socio-Culture in Sustainability: The socio-cultural dimension includes factors such as family participation, local wisdom, and community involvement in livestock businesses. With a value of 71.58%, this shows that the socio-cultural dimension has a fairly good contribution to business sustainability, although there is still room for improvement, (d) Institutional Dimension (Score 65.71%): Institutional Role: The institutional dimension includes policies, regulations, support from government institutions, and organizational structures in livestock businesses. The value of 65.71% shows that although institutions have a

positive impact on sustainability, there are still challenges in terms of strengthening the role of related institutions, (e) Ecological Dimension (Score 65.32%): Condition of the Ecological Dimension: Even though the ecological dimension has a lower score (65.32%), this still shows that environmental aspects need to receive more attention in ensuring higher sustainability. This dimension includes managing livestock waste, efficient use of natural resources, and reducing negative impacts on the surrounding environment.

The findings from the MDS analysis show that the economic and technological dimensions have quite high scores, which indicates that the sustainability of the beef cattle livestock corporation at D'Reppa Cow House is in good condition in these aspects. However, the ecological dimension needs to receive greater attention to improve overall sustainability scores. Therefore, some recommendations that can be considered are:

1. Improved Environmental Management: Focus on managing livestock waste, efficient use of natural resources, and application of environmentally friendly technology.
2. Increased Institutional and Socio-Cultural Awareness: Improve coordination between institutions and strengthen community involvement in livestock activities to increase social and cultural awareness.
3. Strengthening Technological Infrastructure: Continue to invest in technology that supports efficiency and productivity and strengthen training for farmers in the use of new technology.

By paying attention to and improving the ecological dimension as well as strengthening institutional and social culture, D'Reppa Cow House can achieve higher and sustainable sustainability in the long term.

Research conducted by Pinta *et al.* (2020) on coastal cattle breeding at BPTU-HPT Padang Mengatas concentrated on the social dimension. The study employed the Leverage of Attributes Analysis Method to identify key factors affecting coastal cattle breeding at the institution. The most influential attributes in the social dimension impacting the sustainability index include farmers' acceptance of BPTU-HPT Padang Mengatas as a cattle breed provider, the level of education, and the availability of training and counseling.

Research by (Putra *et al.* (2022) found that the sustainability index for the economic dimension falls into the category of being quite sustainable. To assess which attributes most significantly affect the sustainability index value in this dimension, leverage analysis was conducted. This analysis identified six key attributes that notably influence the economic sustainability index: (1) agricultural experience, (2) experience in animal husbandry, (3) number of bulls, (4) land area and types of crops grown, (5) number of female cows, and (6) location of product sales.

Research by (Sulaksono *et al.* (2021) indicates that leverage analysis of ecological attributes reveals that all these attributes significantly affect the sustainability index. To enhance the sustainability status of these attributes in the future, targeted interventions or improvements are necessary. The analysis identifies feed carrying capacity as the most critical attribute influencing sustainability within the ecological dimension. Currently, the feed carrying capacity at the research site is deemed adequate due to its location within an agricultural zone. Ensuring a sufficient supply of feed, such as forage or wild grasses, is crucial for ruminant livestock like cattle. Therefore, maintaining an optimal feed carrying capacity is essential for the effective development of beef cattle farming and the overall growth of the cattle.

Research by (Ramadhan *et al.* (2014) highlights that maintenance management is a crucial factor affecting the sustainability index within the technological dimension of beef cattle businesses in Bondowoso Regency. The application of reproductive technology plays a key role in enhancing the population, productivity, and quality of coastal cattle breeds. To sustain and improve technological sustainability, BPTU-HPT Padang Mengatas needs to enhance the use of technology in reproductive systems, maintenance management, and feed technology for coastal cattle. Currently, BPTU-HPT Padang Mengatas relies on natural mating methods for coastal cattle and has not yet adopted reproductive technologies such as Artificial Insemination due to the unavailability of frozen semen for these cattle.

(Amam and Solikin (2019) observed that livestock institutions can play a crucial role in establishing marketing networks. According to (Stenholm and Hytti (2014) farmers are not merely considered entrepreneurs but also as key players in the development of these networks. Livestock institutions can enhance farmers' access to various resources (Amam and Harsita, 2019), including financial, technological, and infrastructural support (Soetriono and Amam, 2020; Amam *et al*., 2020)), as well as economic, environmental, and social resources (Amam *et al.*, 2020).

Macroeconomic sustainability relies on three core components: economic efficiency, sustainable economic growth, and equitable distribution of wealth. These objectives can be realized through various macroeconomic policies, which encompass fiscal reform, enhancing public sector efficiency, mobilizing domestic savings, managing exchange rates, implementing institutional reforms, fostering effective market forces, investing in social measures for human resource development, and improving income and asset distribution (Sutawidjaya *et al.*, 2024; Scoones, 2022).

***Conclusion*:** Based on the results and discussion, it can be concluded that the corporate sustainability index for beef cattle at the D'Reppa Cattle House, Gowa Regency, is highly

sustainable in the economic dimension. In contrast, the ecological, socio-cultural, technological, and institutional dimensions show a moderate level of sustainability. These results suggest that the attributes used to assess corporate sustainability in beef cattle at the D'Reppa Cattle House, Gowa Regency, adequately cover the five analyzed dimensions. However, there is a need for focused improvements in the ecological dimension, particularly concerning the distance between the beef cattle pens and residential areas, to enhance the overall sustainability of the beef cattle operations at the D'Reppa Cattle House. Policy recommendations for enhancing the sustainability of beef cattle corporations emphasize the need for targeted interventions across economic, environmental, and social dimensions, supported by an integrated framework.

***CRediT author statement*:** Concept and Survey were designed by SR, ARS, TR, MH, PA, and MD; PD and MEK also evaluated the findings; ST, MD, PA, and ARS also created the write-up; and MH, MEK, and ADRU performed statistical analysis of the data and created drawings for journal submission.

***Conflict of interest*:** The authors declare no conflict of interest.

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***Availability of data and material*:** We declare that the submitted manuscript and the data given in this work upon reasonable request, and is not currently being considered for publication elsewhere?

***Code availability*:** Not applicable.

***Consent to participate*:** All authors participated in this research study.

***Consent for publication*:** All authors submitted consent to publish this research. article in JGIAS

***SDGs addressed*:** Zero Hunger, Decent Work and Economic Growth, Responsible Consumption and Production, Climate Action.

***Policy referred*:** National Beef Self-Sufficiency Program (PSDS/KUPS) and Livestock Agribusiness Development Policy.

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